



PATENT SPECIFICATION

DRAWINGS ATTACHED

992.788

Date of Application and filing Complete Specification: April 16, 1964.

No. 15833/64.

Application made in Germany (No. L44637 Ic/27c) on April 16, 1963.

Complete Specification Published: May 19, 1965.

© Crown Copyright 1965.

Index at acceptance :—F1 C(1C, 2B3E)

Int. Cl.:—F 04 d

COMPLETE SPECIFICATION

Improvements in and relating to Multi-Stage Centrifugal Compressors

We, LICENTIA PATENT-VERWALTUNGS-G.M.B.H., a German Company having its registered office at Frankfurt (Main), Theodor-Stern-Kai 1, Germany, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to multi-stage centrifugal compressors and aims at providing an improved construction which makes it possible to increase the overall efficiency of the compressor by improving the efficiency of at least some of the compressor stages where the occurrence of irregularities in the fluid flow due to the formation of boundary layers whose thickness is great as compared with the cross-section of the fluid flow, causing turbulence and separation of flow lines, tends to affect the efficiency of the operation.

This difficulty is overcome by the present invention which resides in a centrifugal compressor including at least two pressure stages each formed by narrowing passages in a rotor surrounded by a ring of stationary guide vanes, the rotor also including a diffuser part, and the ratio of the energy converting effect of the said part to the energy increasing effect of the rotor being greater in the higher one of the two pressure stages as compared with the ratio in the lower pressure stage.

The diffuser effect, that is the conversion of kinetic energy to pressure energy by gradual increase in the cross-sectional area of flow, depends upon the ratio of outlet cross-section to inlet cross-section of the diffuser. Thus the effect can be predetermined by width dimensions in the axial direction of the compressor, or the radial dimension of the diffuser part, of the angle of divergence of the diffuser walls, or by a combination thereof. Where it is desired to maintain a uniform diffuser outlet

[F]

width in the axial dimension of the compressor throughout a number of compressor stages the other parameters mentioned above can be chosen for a required diffuser effect.

More details will become apparent and the invention will be better understood from the following description referring to the single Figure of the accompanying drawing which shows diagrammatically and by way of example a part section of the first three stages of a multi-stage centrifugal compressor according to the invention.

The first, second and third stages denoted 11, 12, 13 have mounted on a common shaft 10 rotors 29, 30, 31 with channels 16, 17, 18. The thickness of the walls or blades defining the channels decreases towards the channel exit. As the gas volume decreases with increasing gas pressure the outer diameter of the rotors of the successive stages decreases as indicated by the inclined dash-dotted line 27. The rotors 29, 30, 31 are surrounded by rings of guide vanes 32, 33, 34.

Since lower pressure stages are less subjected to flow irregularities, the first stage rotor 29 does not include a diffuser part. The second and third stages have adjacent to the loaded rotor channels 17, 18, unbladed diffuser parts 19, 28. The ratio of diffuser action to action of the rotor channel of the same stage is increased for the third stage as compared with that of the second stage. To this end the radial dimension 21 of the diffuser part 28 of the third stage is greater than the radial dimension 20 of the diffuser 19 of the second stage. Also the "opening" angle denoted 23 of the third stage diffuser 28 is greater than the angle 22 of the second stage diffuser 19. The diffuser inlet width 37 is reduced but the diffuser exit width in the axial direction of the compressor could be greater for the higher stage. In many cases however it is preferable to maintain this latter dimension, as shown, and to allow for

stationary guide rings 32, 33, 34 of equal width in the several stages. Thus the dimension 15 of communication channels connecting the stationary vanes to spiral channels 24, 25, 26 of the three stages is similar for the three stages. Each such spiral channel comprises usually two parts, each extending through approximately 180°. Preferably intercoolers are provided between the stages, but are not shown for the sake of simplicity. Modifications are possible without departing from the invention as defined by the appended claims. The "opening" angle may be up to 90°. Since cooling a gas also decreases its volume the invention is particularly advantageous where intercoolers are provided between the compressor stages.

WHAT WE CLAIM IS:—

1. A centrifugal compressor including at least two pressure stages each formed by narrowing passages in a rotor surrounded by a ring of stationary guide vanes, the rotor also including a diffuser part, and the ratio of the energy converting effect of the said part to the energy increasing effect of the rotor being greater in the higher one of the two pressure stages as compared with the ratio in the lower pressure stage.
2. A compressor as claimed in claim 1, wherein the ratio of outer diameter to inner diameter of the rotating diffuser part is greater at the higher pressure stage than at the lower pressure stage.
3. A compressor as claimed in claim 1,

wherein the ratio of diffuser outlet width to inlet width in the axial direction of the compressor is greater at the higher pressure stage than at the lower pressure stage.

4. A compressor as claimed in claim 1, wherein the radial dimension of the diffuser part is greater at the higher pressure stage than at the lower pressure stage.

5. A compressor as claimed in claim 1, wherein the angle between the diverging walls of the diffuser part is greater at the higher pressure stage than at the lower pressure stage.

6. A compressor as claimed in claim 1, wherein the thickness of the rotor blades decreases towards the outlet of the rotor channels.

7. A compressor as claimed in claim 1, wherein rotors preceded by at least one pressure stage are provided with diffuser parts.

8. A compressor as claimed in claim 1, wherein a cooling means is inserted between at least some of the pressure stages.

9. A centrifugal multi-stage compressor substantially as hereinbefore described with reference to or as illustrated in the accompanying drawing.

J. W. RIDDING,
Chartered Patent Agent,
33, Grosvenor Place,
London, S.W.1,
Agent for the Applicants.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1965. Published by The Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

992788

COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of
the Original on a reduced scale*

